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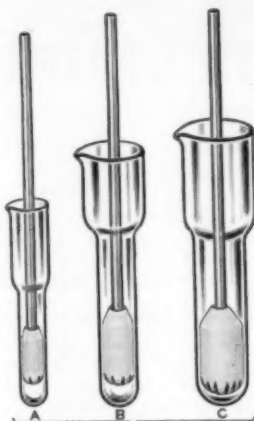
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**Y**ESTERDAY, January 15, the officers elected by the AAAS Council at St. Louis on December 27 assumed their responsibilities for 1953. At the same Council meeting a revised constitution and new by-laws were adopted, and they will become effective January 27. On that date the Executive Committee will be transformed into the Board of Directors, which will consist of the three presidents and eight elected members as named below, plus the Administrative Secretary and Treasurer as ex officio members without vote.

The retirement of Kirtley F. Mather makes Fernandus Payne senior member of the board in length of service (elected 1946). Mark H. Ingraham and Paul E. Klopsteg were re-elected for regular four-year terms, and Wallace R. Brode was elected to complete the unexpired term of Warren Weaver, now president-elect. Among the vice presidents, Clarence E. Davies was chosen to serve a second term as chairman of the Section on Engineering. The complete roster of general officers for 1953 follows:

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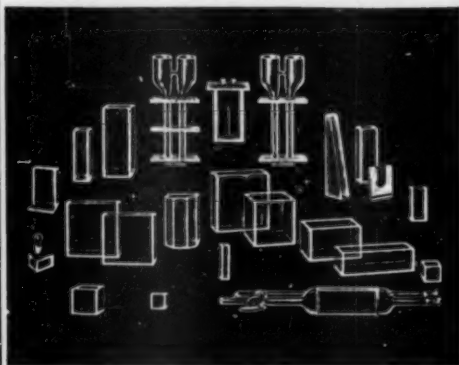
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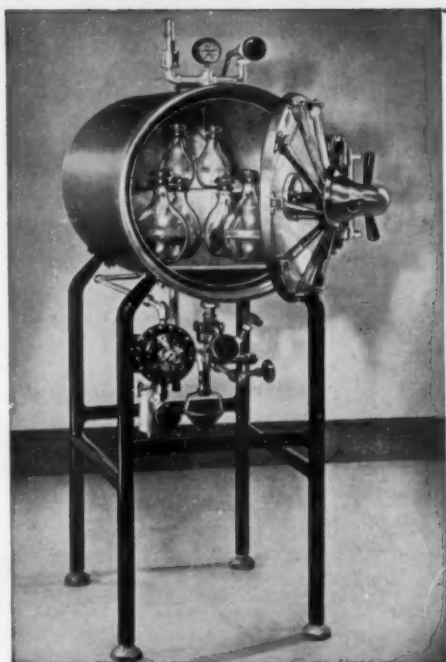


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# Snake Venoms, Their Biochemistry and Mode of Action<sup>1</sup>

Nandor Porges<sup>2</sup>

1301 East Barringer Street, Philadelphia, Pennsylvania

THE VENOM APPARATUS reaches the highest development in poisonous snakes. Many other species throughout the animal kingdom also have the capacity to elaborate poison, and this capacity is manifest in a variety of forms. It is a passive defensive function in frogs, toads, and salamanders, in each of which the venom glands are distributed in the skin. In other animals the venom apparatus is a weapon of offense and defense. The male platypus has a canalized spur on each of his limbs; the spurs are connected to a venom gland on the back of the thigh. Many poisonous fishes have a venom gland at the base of the spine, and in some species the apparatus is important for the capture of food. Corals, jellyfish, and hydra have their stinging organs. Spiders and myriapods have the glands in the mouth, and scorpions and wasps have the venom in the hinder parts. In snakes, the venom glands are actually specialized salivary organs, and inoculation is by the canalized or grooved teeth. The venom not only immobilizes the prey but aids subsequent digestion of the animal tissues.

Snake venoms provide an exciting and absorbing subject for investigation. In the United States 2000-3000 snakebite accidents occur annually, of which 10-35 per cent are fatal. In Europe about 14 deaths are reported yearly, whereas approximately 25,000 deaths occur each year in India. Much study has been devoted to the mechanism by which snake venom causes death of the victim (1-4), and more than 6000 papers have been published on the subject of venoms.

Snake venom is a mixture, chiefly of proteins, varying in composition from species to species. Over 300 species are distributed throughout the world—a fertile field for scientific investigation (Table 1). The poisonous snakes of Europe are the "true" vipers; the Americas have no snakes of this family. Nearly all the poisonous snakes of North and South America are "pit" vipers, of which the rattlesnake is a representative species. Africa has none of the rattler type, and Australia's poisonous snakes are limited to those of the proteroglypha, characterized by permanently erect fangs. Members of all groups are found in Asia.

The venom may vary in a single species, depending on the habitat and on the physical condition of the

TABLE 1  
GEOGRAPHICAL DISTRIBUTION OF VENOMOUS SNAKES

	Viperidae		Colubridae
	Viperinae (true vipers)	Crotalinae (pit vipers)	Proteroglypha
Europe	1 genus (7 species)	0	0
Americas	0	4 genera (50 species)	2 genera (43 species)
Africa	7 genera (46 species)	0	8 genera (30 species)
Asia	7 genera (16 species)	2 genera (27 species)	27 genera (11 species)
Australia	0	0	19 genera (76 species)

snake. The amount ejected may be only a few drops, or as much as 2 ml in a single strike. The dry weights of solids contained in an average ejection of venom have been reported for a few species (Table 2).

In a review of animal poisons, Kellaway (3) recognized in snake venoms the presence of at least two toxic principles and possibly more. These are proteins or substances of protein nature, some having enzymatic properties. Thus the toxic actions of venoms were attributed to proteolytic enzymes, phosphatidases, and neurotoxins.

The proteolytic activity of venoms of the bothropic species (for example, *Bothrops atrox*, or fer-de-lance) was described as early as 1881, but it had been suggested even earlier that reptile poisons might contain agents similar to those of the digestive juices. These substances, in crotaline venoms, produce severe hemorrhagic and destructive effects at the site of the bite, and hemorrhages in the viscera; they give to the venoms their coagulating properties. Explanation of these phenomena was not forthcoming until work on the coagulation of blood led to some knowledge of venom proteases.

Venoms with coagulant properties fall into two groups. The first includes the most powerful proteolytic venoms, which coagulate pure fibrinogen *in vitro* without calcium ions, tissue extracts, or prothrombin. This group has an optimum pH of 6.5, the same as thrombin, but coagulation is unhindered by specific antithrombin. The proteolytic enzymes in these venoms behave like papain, converting fibrinogen into fibrillar gel.

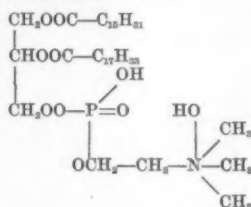
The venoms of the second group, unlike those of

<sup>1</sup> Based on a paper presented at a Seminar on Snake Venoms, sponsored by the Wyeth Institute of Applied Biochemistry, and held at Marietta, Pa.

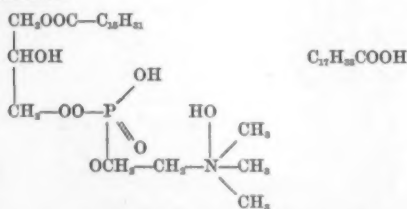
<sup>2</sup> The author is indebted to Eleanor Buckley, of the Medical Department of Wyeth Incorporated, for her interest and suggestions.

the first, are unable to coagulate pure fibrinogen. They convert prothrombin to thrombin. The activity of these substances is analogous to that of trypsin but is many times more potent. The proteolytic enzymes may contribute to the hypotensive action of snake venom through damage to vascular endothelium, with consequent escape of blood from the vessels and possibly liberation of histamine.

The phosphatidases also play a part in poisoning, causing hemolysis and most of the effects on the heart and circulation. Hemolysis by venom is accelerated by lecithin, since oleic acid splits off to form lysolecithin. Lecithin upon complete hydrolysis yields four products: glycerol, fatty acids (palmitic, stearic, oleic), phosphoric acid, and choline. When the phosphatidase, lecithinase, acts on lecithin, oleic acid and lysolecithin are formed, as follows:



A lecithin, glyceryl mono-palmitate mono-oleate, mono-phosphate ester, yields in the presence of lecithinase:



Lysolecithin + Oleic acid

Peculiarly, the lysolecithin itself is actively hemolytic, and its effects on the heart are similar to those of venom. Like some venoms, it acts on isolated muscle and causes, among other effects, contractures, fibrillation, increased inhibition of water, loss of potassium, and excitability. It attacks the capillary endothelium and causes hemorrhage of the lungs. However, because the protein of the plasma offers some protection, large doses are required to kill animals. The hemolytic action of lysolecithin is inhibited by egg albumin in solution. The hemolytic activity of the Australian snake venoms is directly related to their lecithinase content. Cobra venom is more active in dilute than in strong solution, because the lecithin is absorbed by the proteins, which coagulate in the concentrated venom.

The abrupt fall of systemic blood pressure that results when noncoagulant venoms are injected intravenously is caused in large part by the action of phosphatidase in forming lysolecithin and liberating histamine. The venoms from *Crotalus atrox* and *Denisonia*

TABLE 2  
AVERAGE CONTENT OF SOLIDS IN A SINGLE  
EJECTION OF VENOM

Species	Milligrams
<b>Viperidae</b>	
Viperinae (true vipers)	
<i>Vipera aspis</i> (European viper)	8-10
<i>V. russelli</i> (Russell's viper)	200-300
<i>Bitis gabonica</i> (puff adder)	600-1000
Crotalidae (pit vipers)	
<i>Crotalus atrox</i> (Texas diamond-back or red rattlesnake)	90-175
<i>C. terrificus</i> (tropical rattler)	30-60
<i>C. adamanteus</i> (Florida diamond-back or Eastern rattlesnake)	240-437
<i>Agkistrodon piscivorus</i> (water moccasin or cottonmouth)	90-150
<i>C. horridus</i> (timber rattler)	42-90
<i>Bothrops atrox</i> (fer-de-lance)	100-180
<i>B. jararaca</i> (fer-de-lance type viper)	200-330
<b>Colubridae</b>	
<i>Naja haje</i> (Egyptian cobra)	19-48
<i>N. naja</i> (Indian cobra)	*
<i>N. flava</i> (African cobra)	*
<i>Denisonia superba</i> (Australian copperhead)	*
<i>Acanthophis antarcticus</i> (Australian death adder)	*
<i>Bungarus fasciatus</i> (banded krait)	*
<i>Pseustes porphyriacus</i> (Australian black snake)	*

\* Information not available.

*superba* seem to produce a histaminelike effect. *Vipera aspis* venom also increases capillary permeability. More careful study has shown that injection of the venoms of *C. atrox*, *D. superba*, and *Naja naja* causes the liberation of histamine and coagulable protein. The effects of intravenous injection of cobra venom in cats and dogs may be explained by the release of histamine, which exerts most of its action at the site of its liberation. It has been shown that histamine is formed if coagulation is prevented. It appears that the platelets and leucocytes aggregate and then disintegrate, liberating an intermediate substance (a plasma protease), which subsequently releases histamine from its protein-bound inactive form.

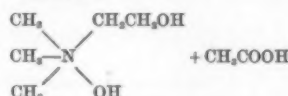
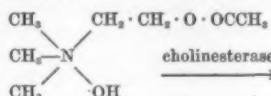
Study of the mechanism of the liberation of histamine by snake venoms has led to recognition of the role of phosphatidases. Lysolecithin is formed in perfused organs when snake venom is injected, and itself liberates histamine from the organs. Lysolecithin formation is an intermediate step in the liberation of histamine by venoms. A substance is also formed that causes subsequent changes in the reactivity of the muscle to histamine and acetylcholine. The part played by lysolecithin in snake venom hemolysis is parallel to its action in liberating histamine. The Australian black snake venom is strongly hemolytic; that of the Australian death adder, feebly so. Increasing the concentration of the latter venom increases histamine output.

The third group of toxic principles, according to Kellaway, comprises neurotoxins, which exert various actions on the nervous tissues and produce a curare-

like effect, as well as paralysis. The venom of *C. terrificus* acts directly on the bulbar centers, whereas those of *V. aspis* and *N. naja* have no such action.

Other enzyme actions have also been observed. The proteases of venoms of the Indian cobra and Russell's viper resemble trypsin. Erepsin has been found, as well as other phosphoesterases. Many of the active principles are apparently complexes of proteins. One that converts hemoglobin to methemoglobin has been isolated (1 g hemoglobin combines with 1.36 ml oxygen, which is released under reduced pressure in the body; the methemoglobin also combines with oxygen but does not release it).

The venoms are proteinaceous, and the nitrogen dis-



tribution is in the following range: total, 13.4–14.8 per cent; albuminoid, 8.8–9.6 per cent; globulin, 3.3–5.2 per cent; and nonprotein nitrogen, 4.6–8.8 per cent. The venoms of the Colubridae contain as much as 3.8–4.8 per cent sulfur; the Viperidae, 1.7–2.5 per cent. The sulfur is associated with the toxic molecule. Colubrine venoms are also high in zinc, having a content of 3.3–5.3 per cent, whereas the viperine venoms contain only 1.1–2.2 per cent. The zinc is associated with the esterase property.

The neurotoxins of cobra venom are concentrated in a protein fraction, containing about 21 per cent of the original protein in the crude venom. One of these toxins has been found to possess a molecular weight between 2500 and 4000; analysis is as follows—C, 45.2; H, 7; N, 14.7; S, 5.5; and ash, 3. This toxin is highly potent; 0.12 µg/g has proved lethal for mice. Another, smaller, molecule has also been obtained; 1 µg is required for a lethal dose.

The neurotoxins of the crotaline venoms are somewhat larger. The neurotoxic activity of *Agkistrodon* venom is reduced by 50 per cent upon dialysis through cellophane; when the dialysate is returned, the activity is regained. Venom from *C. terrificus* has a high sulfur content, present in disulfide form. Cysteine acts on the disulfide bonds, with subsequent loss of activity as a neurotoxin. Cobra venom is not inactivated because another component reacts with cysteine. A proteinlike substance from *C. terrificus* venom has been analyzed as follows: C, 44.9; H, 6.6; N, 13.7; S, 3.6. About 10 per cent of the venom of this snake is an albuminlike, blood-coagulating principle. About 60 per cent of the whole venom contains a neurotoxic principle that is also associated with the hemolytic principle. This substance—crotoxin—has a molecular weight of about 30,000; the empirical formula is  $\text{C}_{1386}\text{H}_{2080}\text{O}_{470}\text{N}_{373}\text{S}_{41}$ . Crotoxin contains eighteen amino acids: arginine, histidine, lysine, leucine, isoleucine, aspartic acid, glutamic acid, proline, phenylalanine, tryptophane, tyrosine, serine, threonine, glycine, alanine, valine, cysteine, and methionine (5).

In 1948 Zeller (4) reviewed the extensive studies published during the previous decade. Zeller believes snake venoms are potent sources of biological catalysts that are not accidental components of the venoms. Although knowledge is still limited, the enzymes are now apparently considered the real toxic principles of venoms, either through their own activity or through their influence on other reactions.

An acetylcholine-inactivating enzyme found in cobra venom by Indian workers aroused great interest because of the possible relationship to the neurotoxic principle of the cobra poison. This enzyme acts on acetylcholine to produce choline and acetic acid as follows:

Apparently there are different types of cholinesterase: one obtained from erythrocytes; another from serum; and the c-type, from colubrine venoms. This enzyme is related to the mechanism of nerve action and is located on the neuron surfaces. On the basis of the cholinesterase content, snake venoms seem to fall into two groups, the venoms of the Colubridae being characterized by the presence, and the venoms of the Viperidae by the absence, of cholinesterase. These, the most active cholinesterases known, act also on noncholine esters. The  $Q_{\text{ChE}}$  of certain of these venoms are shown in Table 3. For comparison, values obtained with red blood cells and a purified product from the cells are given.

TABLE 3  
CHOLINESTERASE ACTIVITY OF SNAKE VENOMS ( $Q_{\text{ChE}}$ )

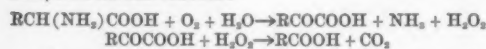
<i>Naja melonoleuca</i>	27,900
<i>N. naja</i>	13,000
<i>Bungarus fasciatus</i>	18,700
<i>Denisonia superba</i>	11,000
<i>Pseudechis australis</i>	90
<i>N. nigricollis</i>	40
Red blood cells (human)	48
Red blood cells (purified product)	8,400

In 1936 an agent was found in snake venoms that enhances the spreading of dyestuffs and infectious agents in the skin of animals. This agent is also present in invasive bacteria, other types of venom, mammalian testes, and autolysates of pneumococci. The "spreading factor" was identified with the substance that depolymerizes hyaluronic acid, the mucopolysaccharide that binds water in the interstitial spaces and holds the cells together in a gel. Hyaluronic acid has the important function of resistance to penetration by foreign matter. This resistance breaks down under the action of hyaluronidase. Hyaluronic acid consists of glucosamine, glucuronic acid, and

\*  $Q_{\text{ChE}}$ —ml  $\text{CO}_2$  liberated per hour from a bicarbonate solution by a milligram of dried venom in the presence of excess acetylcholine.

acetic acid, and has a molecular weight between 200,000 and 500,000. It is found free or in combination with proteins. Venoms of various species differ in hyaluronidase activity as measured by dye-spreading and reduction of viscosity. Other diffusing principles are probably present also.

In 1944, a nonhydrolytic enzyme, L-amino acid oxidase, was demonstrated in *V. aspis* venom. The interaction between this enzyme and its substrates follows two pathways. If catalase is present, the amino acid is changed to an alpha keto acid and ammonia is liberated thus:  $RCH(NH_2)COOH + \frac{1}{2}O_2 \rightarrow RCOCOOH + NH_3$ . If catalase is absent, the reaction takes place in two steps, the final products being ammonia, fatty acid, and carbon dioxide:



This enzyme oxidizes all monoaminomonocarboxylic acids except glycine and threonine. Alanine and serine are oxidized with low velocity; leucine and methionine, with high velocity. The configuration of the aliphatic chain has an effect on the interaction between the substrate and the enzyme, as shown by the action of *Bitis gabonica* venom on  $\alpha$ -aminocaproic acids. The  $Q_{O_2}$ , or microliters of oxygen used per milligram of venom, is shown in Table 4.

TABLE 4  
OXYGEN UTILIZATION BY *Bitis gabonica* VENOM ACTING ON ALPHA AMINOCAPROIC ACIDS

Amino acid	$Q_{O_2}$
Isoleucine, $CH_3-CH_2-CH-CH_2-CH(NH_2)-COOH$	158
Leucine, $CH_3-CH(CH_3)-CH_2-CH(NH_2)-COOH$	584
Norleucine, $CH_3-CH_2-CH_2-CH_2-CH(NH_2)-COOH$	284

The diaminomonomocarboxylic and monoaminodicarboxylic acids are acted upon more slowly than the above acids. This is the first time that several of the amino acids have been attacked enzymatically or have been oxidatively deaminated *in vitro*. For this action to proceed, the substrate must have a free carboxyl group, an unsubstituted  $\alpha$ -amino group, and an organic radical. A second amino or carboxyl group has an inhibitory effect. This enzyme, found in snake venom and snake tissue, has properties different from other amino acid-oxidizing enzymes and has been named L-ophio-amino acid oxidase, or ophio-oxidase. The amount of activity is specific for a genus; of the pit vipers, the genus *Bothrops* has higher activity than the genus *Crotalus* when leucine is used as a substrate. A few selected  $Q_{O_2}$  values are given in Table 5.

As mentioned previously, the rapid diffusion of venoms is prevented by the intercellular gel of the connective tissues, which forms a strong barrier. This barrier may be overcome with the aid of hyaluronidase, a solubilizing enzyme. The spreading action of hyaluronidase in turn may be inhibited by the invaded organism through the liberation of an antihyaluroni-

TABLE 5  
L-OPHIO AMINO ACID OXIDASE ACTIVITY OF SOME VENOMS ON L-LEUCINE ( $Q_{O_2}$ )

<i>Naja naja</i>	100
<i>Bungarus coeruleus</i>	250
<i>Agkistrodon piscivorus</i>	380
<i>Bothrops atrox</i>	760
<i>Crotalus viridis</i>	270
<i>C. adamanteus</i>	50
<i>Vipera aspis</i>	610
<i>V. russellii</i>	760

dase called anti-invasin I. It is associated with the pseudoglobulin fraction of animal sera. It has been found that, oddly enough, the hyaluronidase of *Agkistrodon piscivorus* is not inactivated by the serum. Later it was discovered that a heat-labile agent present in the venom inactivates anti-invasin I, and is now termed proinvasin I. The proportion of hyaluronidase to proinvasin I varies. Some venoms contain large amounts of proinvasin I; hence destruction of anti-invasin I is rapid, permitting the hyaluronidase to act and favoring speedy invasion by the venom. In the presence of small amounts of proinvasin I, destruction of anti-invasin I is slight. Thus hyaluronidase is destroyed by the excess anti-invasin I, preventing invasion by the venoms.

The proinvasin I of snake venom may be destroyed by another agent called anti-invasin II. This mechanism is under study.

Investigations on snake venoms continue. Recent studies (6) on ribonuclease and desoxyribonuclease activity of venoms have been reported, and the data are compiled in Table 6. Venoms with the greatest neurotoxic potency exhibit highest ribonuclease and desoxyribonuclease activity. Venoms with the strongest blood-clotting and proteolytic activity have the least nuclease activity. Substances that inactivate venoms inactivate ribonuclease and desoxyribonuclease. Apparently, the hydrolyzing action of these enzymes probably implements the toxicity of venoms by supplementing the hydrolytic activity of other enzymes known to be present in venoms.

TABLE 6  
NUCLEASE ACTIVITIES OF SNAKE VENOMS\*

	Ribonuclease	Desoxyribonuclease
	$Q_{CO_2}$	$Q_{CO_2}$
<i>Bothrops alternata</i>	3.8	7.1
<i>B. atrox</i>	3.7	6.6
<i>B. jararaca</i>	4.4	8.2
<i>B. neuwiedii</i>	4.4	6.9
<i>Crotalus terrificus</i>	7.2	10.3

\*  $Q_{CO_2}$  = ml  $CO_2$  liberated/hr/mg venom from suitable substrate.

From the anatomical, physiological, and biochemical findings, the biological significance of snake venoms is primarily in their digestive role. Snakes can-



TABLE 7

WEIGHT IN MG OF VENOM LETHAL INTRAVENOUSLY FOR RABBIT

<i>Vipera aspis</i>	0.35
<i>V. russellii</i>	0.05
<i>Bitis gabonica</i>	2.13
<i>Crotalus terrificus</i>	0.25
<i>C. adamantus</i>	0.25
<i>Bothrops atrox</i>	0.01
<i>Naja flava</i>	0.15

not chew and mix the products of their salivary glands with the tissues of their prey. Instead, they use a highly developed injection apparatus to apply digestive agents to their food. These powerful and concentrated enzymes exert an extremely poisonous effect (Table 7). For comparison, 0.15 mg crystalline urease of plant origin, injected intravenously, will kill a rabbit through production of ammonia from urea.

In addition to the enzymes commonly found in the digestive juices of other animals, most snake venoms contain hyaluronidase and ophio-oxidase. The poisons must spread rapidly in the body of the prey to fulfill their physiological purpose. The hyaluronic acid gel and fibers of the connective tissues are invaded through destruction of anti-invasin I by the action of proinvasin I. Venoms, especially of the Viperidae, produce other local effects, such as increased permeability, through destruction of substance surrounding the blood vessels. Lecithinases attack the lipid layer of the endothelial cell surfaces, producing lysolecithins that expand the film, with consequent increase in fragility and permeability.

Powerful proteases lead to actual dissolution of blood vessels, causing spreading of erythrocytes and serum into the tissue. The spreading of venom is greater than can be accounted for by the hyaluronidase content and is explained by the action of lecithinases and proteases. Necrosis at the site of a bite is due to the primitive digestive properties of snake venoms.

Ophio-oxidase is not present in all venoms and is not required for the deleterious effects of snakebite. It is a nontoxic component that causes a protease-enhancing effect by liberating proteases and peptides bound up in the cell itself. It is a digestive agent, activating proteolytic enzymes present in the victim's body. It hastens autolysis and putrefaction. For example, the tissues of a rat injected with venom are digested about twice as rapidly as those of an untreated rat.

The biochemistry and mode of action of snake venoms are obviously complex. Boquet (1) concludes that a study of venoms requires knowledge and investigation of a great number of factors, among them the toxic action, the enzymatic activity, and many other diverse properties. Each of these is further divided and subdivided into smaller groups, many of which have been mentioned or discussed in this presentation.

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## News and Notes

### Jubilee Meeting of the South African AAS<sup>1</sup>

THE South African Association for the Advancement of Science was founded in Cape Town about 50 years ago; 18 months later—in 1903—Sir David Gill, His Majesty's Astronomer at the Cape, presided over the first annual congress. Since then the association has met annually, and these meetings have taken the association to all the larger towns in Southern Africa. For the Jubilee Congress it seemed fitting to return to Cape Town, where the association was born. The congress was held under the presidency of B. F. J. Schonland July 7-12, in the buildings of the University of Cape Town. The generosity of the Union government made it possible for the association to invite guests from overseas. From the United Kingdom came Sir Lawrence Bragg, director of the Cavendish Laboratory, and Sir Edward Salisbury, director of Kew Gardens; Holland sent L. E. J. Brouwer, founder

of the Intuitionist School of Mathematics, and J. F. Oort, of Leiden Observatory; Canon G. le Maitre and G. Magnel came from Belgium; and from France, H. Vallois, the anthropologist of the Musée de l'homme in Paris. Portugal, which played such an important role in the early development of South Africa, sent historian A. de Silva Rego. Die Suid-Afrikaanse Akademie vir Wetenskap en Kuns was represented by its chairman, T. E. W. Schumann, director of the Weather Bureau of the Union of South Africa. Sir Kerr Grant, Australian physicist, represented the Australian and New Zealand AAS, and J. D. J. Hofmeyr, head of the Department of Genetics, University of Pretoria, represented the sister association in the United States of America. R. W. James, of the University of Cape Town, was present as the representative of the Royal Society of South Africa, the oldest scientific organization in the country, which this year celebrates its seventy-fifth anniversary.

The meeting began with a formal welcome to the

<sup>1</sup> From an editorial in the *South African Journal of Science*.

city by the Mayor of Cape Town, Councillor Sonnenberg, who later in the week entertained the delegates at a Civic Ball in the Cape Town City Hall.

The president delivered his presidential address on the evening of July 7 in the hall of the Cape Town Technical College, which was decorated for the occasion with banners bearing the names of the association's past presidents. The Mayor welcomed the Minister of Education, Arts and Science, J. H. Viljoen, who took the chair and delivered an opening address. The official visitors read messages from the governments and societies which they represented and handed them to the president. Messages of greeting were received from:

The British Association for the Advancement of Science  
Koninklijke Nederlandse Akademie van Wetenskap  
Association française pour l'avancement des sciences  
American Association for the Advancement of Science  
Suid-Afrikaanse Akademie vir Wetenskap en Kuns  
Scientific Council for Africa South of the Sahara  
South African Council for Scientific & Industrial Research  
Sociedade de estudos da colonia de Moçambique  
Australian and New Zealand Association for the Advancement of Science

Royal Society of South Africa

Het Nationale fonds voor Wetenschappelyk onderzoek  
Bruxelles

Dr. Schonland reviewed the history and accomplishment of the association, paying tribute to many former members—men like Gill, Gilchrist, Reunert Hahn, Theiler, and du Toit, to mention just a few—whose energy and foresight built up the scientific services of the country. He went on to show that in the next half-century the association will have a different task. There is no longer need to plead for the recognition of science, nor for the facilities for training of men and the provision of money for scientific work and research. What is more urgent now is to integrate scientific work and human needs, and to do something to lessen the gap of ignorance between men of science and the public—a gap that is widening as scientific specialization proceeds. Scientists should mix with others with a different outlook, and by discussion with them give new life to the scientific fraternity as a whole. By scientific meetings of a general kind, and by interest in scientific education in schools and universities, they should see that those who should understand the significance of scientific work are given opportunities to do so. He urged a new outlook of service to the community as well as to science itself.

The association's guests took part in the sectional meetings and excursions that were held throughout the week. Three sectional presidential addresses were delivered. Addressing Section B, M. R. Levyns, of the Department of Botany in the University of Cape Town, recounted the history of the Cape flora. Since flowering plants first appeared South Africa has not experienced an event like the Pleistocene Ice Age. It is possible to trace the origin of the Cape flora in Central Africa, whence it migrated southward following the mountains—the eastern escarpment of the

plateau. Today the Cape flora occupies a small area, with Caledon near the center—mainly the coastal plains from St. Helena Bay to Port Elizabeth.

R. Eldson-Dew's presidential address to Section E told something of the contribution of protozoology to the medical and veterinary sciences. He referred to the ravages of malaria, which each year kills between two and three million persons, and to the trypanosomes, which make it impossible to rear cattle in one fourth of Africa. He recalled the work of David Braice and Arnold Theiler, and stressed the great debt that South Africa owes to the protozoologists.

S. Biesheuvel, director of the National Bureau of Personnel Research, chose as the subject of his presidential address before Section F "The Nation's Intelligence and its Measurement." He spoke of the shortage of men with professional, technical, and administrative skills and capacity for leadership, and of the need for detecting these qualities early and developing them to the maximum capacity of the individual. The technique of intelligence-testing is limited, and it seems preferable to use validated aptitude tests. Dr. Biesheuvel also examined, from South African data, the possible decline in national intelligence resulting from the tendency of the more intelligent persons to have small families.

The excursions were skillfully planned and well attended, and it was fortunate that during the week Cape Town, which is usually wet and windy in winter, enjoyed warm, sunny weather. Parties visited *Afrikaner II*, the South African Fisheries Research vessel, and the Rondevlei Bird Sanctuary, the only observational station of its kind in the Union. F. Walker, of the Department of Geology, led a geological excursion to the Cape Peninsula, visiting first the Chapman's Peak cutting and then the raised beaches and granite intrusions near Sea Point. Another party went to the Cape Town Municipal Water Supply at Steenbras and saw the seven-mile lake in the Hottentots Holland Mountains.

Executives of African Explosives and Chemical Industries Limited showed their factories at Somerset West; the director and trustees entertained a party at the National Botanic Gardens, Kirstenbosch. There was a historical excursion to the Castle of Cape Town, followed by a visit to Groot Constantia, the old homestead of Governor Simon van der Stel, and to the Department of Inland Fisheries, where research is done on fish suitable for South African waters and from which fish are sent to stock South African rivers and reservoirs.

On the last evening of the congress, R. H. Stoy and Mrs. Stoy were at home at the Royal Observatory—a now famous institution, which owes so much to the work of Sir David Gill, the association's first president.

Submitted by  
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## Scientists in the News

Wallace Akers, director of Imperial Chemical Industries Ltd., and Philip Johnson, director of Hawthorn Leslie and Co., Ltd., and chairman of the Parsons and Marine Engineering Turbine and Development Association, have been appointed members of the Advisory Council for Scientific and Industrial Research (UK), succeeding P. I. Dee, retired, and Hugh Warren, resigned.

Edward Appleton, principal and vice-chancellor of the University of Edinburgh since 1949, and formerly Wheatstone professor of physics at the University of London (King's College) and Jacksonian professor of natural philosophy at the University of Cambridge, has succeeded A. V. Hill as president-elect of the British Association for the Advancement of Science. In 1947 he was the recipient of the Nobel Prize for Physics.

Ida Barney, research associate in astronomy at Yale University, has received the Annie J. Cannon Prize for her "distinguished contribution to astronomy." The prize, awarded at the winter meeting of the American Astronomical Society, was established in 1934 to honor outstanding women in astronomy. Women of all countries are eligible, and the prize is awarded not oftener than once every three years. Miss Barney was cited for her work in completing one of the most extensive photographic mapping jobs ever undertaken by a single observatory. The 13-volume Yale Photographic Zone catalogues required half a million measurements and 23 years of computations before completion in 1950.

Lawrence W. Bass, industrial research executive, has joined Arthur D. Little, Inc. He will work primarily as a consultant on the effective organization and management of industrial research activities. Dr. Bass has most recently been vice president in charge of research for U. S. Industrial Chemicals Company.

On Feb. 26, the Buffalo Surgical Society will sponsor the Roswell Park Lecture, to be given this year by Warren H. Cole, professor and head of the Department of Surgery at the University of Illinois College of Medicine. Dr. Cole will be awarded the society's Gold Medal, being given for the sixth time, in honor of Dr. Roswell Park.

Volney R. Crosswell, a veteran of nearly 41 years' service with Hercules Powder Company, retired on Dec. 31. Mr. Crosswell was manager of safety for three Hercules departments—Naval Stores, Paper Makers Chemical, and Synthetics.

J. Griffiths Davies, associate chief of CSIRO's Division of Plant Industry, has transferred to Brisbane to take charge of expanded research on agricultural problems of northern areas. Dr. Davies will extend the successful work of the existing plant research team based on Brisbane under the leadership of T. B. Paltridge.

Emanuel E. Ericson, professor of industrial arts at Santa Barbara College of the University of California and assistant director of University Extension, was named recipient of the Ship's Citation, at the recent national convention of the American Vocational Association in Boston, for his "unstinted devotion and constant service to industrial arts, to vocational education, and to education in general."

Malcolm Farmer, former director of the Museum of Man, San Diego, has been appointed assistant director of the Museum of Northern Arizona, Flagstaff, as of July 1. A new one-story building, covering about 12,000 square feet, will be added to the Research Center of the museum to house the library, laboratories, and study collections. Work will begin on this new unit as soon as weather permits in the spring of 1953.

Wayne M. Faunce, until recently vice director and executive secretary of the American Museum of Natural History, has been appointed administrative consultant to the director.

Wiley D. Forbus, Duke University pathologist, has been appointed consultant to the U. S. Atomic Energy Commission's Division of Biology and Medicine. Dr. Forbus will serve as consultant in the South on pathological problems relating to claims of radiation and other injuries against the government.

J. C. Gilson has been made director of the Pneumonia Research Unit at Llandough Hospital, operated by the Medical Research Council. Formerly assistant director, he succeeds Charles Fletcher, who has accepted a position in the Postgraduate Medical School of London.

Wilfrid D. Hambly, curator of African ethnology for the past 26 years, and Milton D. Copulos, artist preparator in the plant reproduction laboratories of the Department of Botany of the Chicago Natural History Museum, retired Dec. 31. Hugh C. Cutler, curator of economic botany, has resigned to accept a position with the Missouri Botanical Garden. Luis de la Torre, who has been a collector for the museum on zoological expeditions to Guatemala, has been appointed associate in the Division of Mammals.

Joseph M. Hayman, Jr., of Cleveland, has been appointed dean of the Tufts College Medical School, succeeding Dwight O'Hara, who recently resigned. Dr. Hayman is professor of medicine in the Western Reserve Medical School and is associated with the Lakeside Hospital, Cleveland. Dr. Hayman will also hold a professorship of medicine at Tufts and will be senior physician in the New England Center Hospital and the Pratt Diagnostic Clinic, for which the school is the teaching base. He begins his new duties Apr. 1.

LeRoy P. V. Johnson, professor of genetics and plant breeding, University of Alberta, has accepted a one-year appointment with FAO. He will join the

United Nations Mission to Libya as agricultural officer, with headquarters in Rome and post of duty in Tripoli.

**Paul E. Klopsteg**, assistant director for Mathematical, Physical and Engineering Sciences of the National Science Foundation, has been appointed to the new position of associate director of the foundation. **Raymond J. Seeger**, program director for physical sciences, has been appointed acting assistant director for Mathematical, Physical and Engineering Sciences. In his new capacity, Dr. Klopsteg will be responsible for assisting the director and the deputy director of the foundation in following closely the development of relationships with universities and with other federal agencies; he will also handle special assignments of importance to the scientific programs of the National Science Foundation.

**Mark Leum**, of the University of Iowa, has been appointed a mathematician at the Woodward Governor Company.

**Virgil E. Neilly**, assistant professor of engineering at Pennsylvania State College, has been appointed secretary of the Engineering College Research Council, succeeding **John I. Mattill**, now director of publications at MIT.

**R. J. S. Pigott**, director of engineering, Gulf Research & Development Company, retired on Jan. 1. He will, however, continue in the capacity of consultant.

**Ray W. Retterer** was recently appointed administrator of International Business Machines Corporation engineering, in which position he will head engineering administration for all IBM laboratories. He was previously administrator of the Poughkeepsie, N. Y., laboratory.

**Arnold M. Rose**, Department of Sociology, University of Minnesota, was awarded the new AAAS \$1000 prize in social science theory, which was established in 1951 but was given for the first time at the AAAS meeting in St. Louis last month. **Stuart C. Dodd**, director of the Washington Public Opinion Laboratory, University of Washington, received honorable mention. The prize was given to Dr. Rose on the basis of independent ratings of nearly 60 entries by three judges—George A. Lundberg, University of Washington; Kenneth H. Parsons, University of Wisconsin; and Sidney Ratner, Rutgers University. The competition will be continued in 1953, and announcement of the conditions for this year's prize will appear in *SCIENCE* on or about Mar. 6.

**Robert B. Sosman**, professor at Rutgers University, ceramist and authority on silica and refractories, has been named the 1953 recipient of the Albert Victor Bleining Award, the highest honor conferred in this country for "distinguished achievement in the field of ceramics." It is given annually by the Pittsburgh Section of the American Ceramic Society.

## Education

In an effort to assist universities in obtaining outstanding lecturers for special courses and seminars, the **American Society for Metals** has established a visiting lectureship program. The society will defray the expenses of visiting scientific lecturers for a maximum of four days at a given university, and local chapters will cooperate in organizing the lecture or seminar course. Only one program may be secured by a university during any single school year. Application blanks may be secured from the executive offices of the society, 7301 Euclid Ave., Cleveland 3.

**Boston University School of Education** will sponsor a ten-week European study trip next summer to acquaint mathematics and science teachers with the background and resources of England, Scotland, Norway, Sweden, Denmark, the Netherlands, Germany, Switzerland, and France. **H. W. Syer**, of Boston U, will act as director of the tour and guide to the cities. Plans will be made in advance for the group to be met by mathematics and science teachers from the country being visited, officials from the ministries of education, and museum and laboratory experts. For further information, write to Dr. Syer, 322 Bay State Road, Boston.

**Brandeis University** will start graduate work in chemistry in September. Faculty, and laboratory and library facilities, are now being enlarged for this purpose. Fellowships, assistantships, and scholarships are available to qualified students. Address the chairman, School of Science, Brandeis University, Waltham 54, Mass.

The **University of California** at Los Angeles has appointed **Howard B. Lewis**, John Jacob Abel university professor of biological chemistry at the University of Michigan, visiting professor of physiological chemistry in the School of Medicine for February, March, and April. **Ralph W. McKee**, of New England Deaconess Hospital and Harvard Medical School, has been appointed professor of physiological chemistry in the School of Medicine.

The **University of Illinois College of Education** is inaugurating a course in comparative education for its foreign students, who necessarily lack background experience as pupils in the American educational system. Selected schools will be visited to observe public education in action.

The **Executive Development Program** at **Massachusetts Institute of Technology** will be substantially expanded next year. Participation in the program is limited to recipients of Sloan Fellowships, competition for which closes on Feb. 21. Nomination by an employer is a prerequisite, and awards range up to \$3860 for married men. Complete information and application blanks may be obtained from the program director, **Gerald B. Tallman**, MIT School of Industrial Management, 50 Memorial Drive, Cambridge 39.



## Grants and Fellowships

The American Society for the Study of Sterility will award a prize of \$1000 for the most outstanding contribution to the subject of infertility and sterility, and the winning essay will appear on the program of the 1953 meeting of the society. Essays must be submitted not later than *Mar. 1*. For full particulars address the society, c-o Herbert H. Thomas, 920 S. 19th St., Birmingham, Ala.

Armour Research Foundation of Illinois Institute of Technology, 53 W. 33rd St., Chicago 16, is offering industrial research fellowships in physics, chemistry and chemical engineering, metallurgy, ceramics and minerals, engineering mechanics, and electrical engineering to begin in September. Fellows, who must be U. S. citizens under 28, holding a B.S. from an accredited school, will be paid \$165 a month during the first academic year, \$325 a month with a two-week paid vacation during the summer, and \$190 a month during the second academic year. Successful candidates will be encouraged to accept full-time employment at \$300 a month next summer. Applications received prior to *Mar. 15* will be given first consideration.

The National Council to Combat Blindness, Inc., 1186 Broadway, New York 1, will consider applications for 1953-54 grants-in-aid received not later than *Apr. 15*. The council encourages projects encompassing the scientific principles related to the study of sight—both normal and pathological—including the various branches of biological, chemical, and physical science and clinical investigative medicine.

The National Research Council Committee for Research in Problems of Sex expects funds to be available for grants-in-aid during the fiscal period July 1-June 30. Information and application blanks (returnable by *Feb. 16*) may be obtained from the secretary, Division of Medical Sciences, NRC, 2101 Constitution Ave., Washington 25, D. C.

The Damon Runyon Memorial Fund made allocations totaling \$152,244 during November. Schools receiving grants were Columbia; University of Minnesota; Utah State Agricultural College; Ursuline College, Louisville, Ky.; and Stanford University. The Memorial Center for Cancer and Allied Diseases; the Trudeau Foundation; Presbyterian Hospital, New York City; and Mount Zion Hospital, San Francisco, also were aided in the continuation of various research projects. Columbia University, College of Physicians and Surgeons, received a special fellowship grant to make a study of "Cytochemistry of Differentiation and Regeneration."

The Textile Research Institute will award three predoctoral fellowships at Princeton University for 1953-54, in the fields of chemistry or chemical engineering. A stipend of \$1200 and payment of university fees are provided for first- and second-year fellows, and \$1800 and fees for third-year fellows.

## In the Laboratories

The Nitrogen Division of Allied Chemical & Dye Corporation will invest more than \$4,000,000 in expanding its urea products plant at South Point, Ohio. The urea synthesis capacity will be doubled, and facilities will be installed to produce a pebbled urea fertilizer compound and an improved urea cattle feed compound. It is expected that construction will be completed early in 1954.

The Associated Portland Cement Manufacturers, Ltd., recently opened new research laboratories and general offices at Stone, in Kent, England. The laboratories are well designed and equipped for engineering research on manufacturing techniques and products, and for fundamental research in the chemistry and physics of cement manufacture. A library and lecture room provide the physical facilities for instruction of personnel in cement technology.

Bauer & Black are constructing new and larger laboratories to house research and development facilities at the Chicago plant. Among the new features will be an animal hospital for the clinical testing of company products and a separate laboratory for radioisotope research.

Construction has begun on the \$826,000 Cancer Research Unit, a part of the \$20,000,000 Medical Center on the Los Angeles campus of the University of California. The unit is being jointly financed by the U. S. Public Health Service and the university.

Chemstrand Corporation has appointed James S. Tapp and Wilfred K. Wilson group leaders in the Research Development Department. H. Dewey DeWitt, W. A. Hooper Huffman, Kenneth R. Lea, Alton E. Peacock, Paul W. Gann, Richard D. Radford, and Calvin J. Waitkus have also joined the department.

The Engineering Division of Gulf Research & Development Company has been divided into the Engineering and Automotive Engineering divisions. E. Topanelian, Jr., has been appointed director of engineering, with Bruce R. Walsh as assistant director, and J. Edward Taylor will be director of automotive engineering, with Charles R. Butler and R. L. Kirkpatrick as assistants.

The Hotel-Dieu Hospital of Montreal has opened a new Clinical Research Department, under the direction of Jacques Genest, formerly of Johns Hopkins Hospital and the Rockefeller Institute for Medical Research. Main emphasis will be on problems related to the mechanism of edema and to hypertensive disease and their relation to the sodium-retaining factor of the adrenal glands.

Recent additions to the staff of Arthur D. Little include the following: Caleb Warner, Harold Sutphen, Jr., Daniel F. Comstock, Francis J. Zimmerman, and George C. Sweeney, Jr.



## Meetings and Elections

The American Chemical Society's Philadelphia Section will hold a Meeting-in-Miniature at the Broadwood Hotel Jan. 29. There will be seven sections—Analytical, Biological, Organic, Industrial, Petroleum, Physical and Inorganic, and Chemical Education—at which about 90 papers will be presented.

The American Psychoanalytic Association, at its regular winter meeting in New York, elected the following officers for two-year terms: president, Ives Hendrick; president-elect, Maxwell Gitelson; secretary, Richard L. Frank; treasurer, Robert T. Morse. They will take office at the next meeting of the association, to be held at the Hotel Statler, Los Angeles, Apr. 30–May 3.

The American Psychosomatic Society has changed the date of its annual meeting—to be held at Chalfonte-Haddon Hall, Atlantic City—to April 18–19.

The Association Canadienne-Française pour l'Avancement des Sciences has elected C. Ouellet, of Laval University, first vice president, and Leon Marion, director of the Division of Pure Chemistry of the National Research Council of Canada, second vice president.

The sixth International Congress for Microbiology, to be held at the University of Rome, Sept. 6–13, will include the following sections: General Microbiology (cellular structure, physiology, etc.); Special Microbiology (bacteria, fungi, viruses and rickettsiae, protozoa, transmitting agents, etc.) applied to human, animal and vegetal pathology, and to hygiene, agriculture and industry; Immunology; and Classification and Nomenclature of Microorganisms. Any member attending the congress may present, in the different sections, communications regarding original scientific research. Arrangements are also being made for symposia on Microbial Metabolism; Nutrition and Growth Factors; Growth Inhibition and Chemotherapy; Host-Virus Relationships; Microbial Cytology; Actinomycetes. Subscription to the congress entitles members to take part in the discussions, receive the abstracts of the communications, attend receptions, and take part in excursions and social activities. American investigators who would like to participate may send their names, tentative titles, and brief indications of subject matter in duplicate to the representative of the SAB in the International Association, Stuart Mudd, Department of Microbiology, School of Medicine, University of Pennsylvania, Philadelphia 4. Dr. Mudd will forward these to the organizing committee. The National Science Foundation will defray partial travel expenses of a limited number of American microbiologists. Applications for travel aid should be sent to the National Science Foundation, Washington 25, D. C. Deadline for receipt of applications is April 15.

The expenses of a limited number of American geneticists attending the ninth International Genetics Congress in Bellagio, Italy, Aug. 24–31, will be par-

tially defrayed by the National Science Foundation. Deadline for receipt of applications is Feb. 1. Persons who have submitted applications to the Genetics Society need not reapply, since all applications will be reviewed at the same time.

A meeting of the USA National Committee of the International Scientific Radio Union (URSI) and the Institute of Radio Engineers Professional Group on Antennas and Propagation will be held at the National Bureau of Standards, Washington, D. C., Apr. 27–30. Sessions will be held on the following topics: Radio Measurement Methods and Standards; Tropospheric Radio Propagation; Ionospheric Radio Propagation; Terrestrial Radio Noise; Radio Astronomy; Radio Waves and Circuits, Including General Theory; Electronics. A preliminary program and advance registration forms will be available after Mar. 16. These and further information concerning the meetings may be obtained from A. H. Waynick, secretary, USA National Committee of URSI, Pennsylvania State College.

The date of the eighth congress of the International Society for Cell Biology (Cytology Congress) has been changed from 1953 to 1954. It will be held in Leiden Sept. 1–7 under the presidency of E. Newton Harvey. P. J. Gaillard, of the Laboratory for Experimental Histology, University of Leiden, is president of the Dutch committee. Correspondence should be addressed to the secretariat, c/o W. H. K. Karstens, State University, Nonnensteeg, 3, Leiden. Members of the society, and candidates for membership approved by the International Committee, may introduce two guests at the congress, and nonmembers will be admitted as space permits. Nominations for new members, which may be made by any member, should be sent with a statement of qualifications and a list of the nominee's publications to J. F. Danielli, Zoology Department, King's College, London, W. C. 2, to be acted on by the International Committee.

The Henry Phipps Institute of the University of Pennsylvania will celebrate its 50th anniversary with a special program Feb. 2–7. Principal speakers will be J. Burns Amberson, Elizabeth K. Porter, Thomas Parran, William H. DuBarry, and Robert T. McCracken.

Two new branches of the Walter Reed Society are being organized, one at the Oklahoma Research Institute and Hospital, Oklahoma City, with Edward C. Reifenshtein, Jr., as chairman of the organizational committee, and one in Los Angeles, with Hans Zinsser as chairman.

A Symposium on Retinal Diseases will be held Mar. 30–31 under the sponsorship of the Department of Ophthalmology, College of Medicine, State University of Iowa. The following speakers will participate: George Wald, Herman Elwyn, Henry P. Wagnier, Jonas S. Friedenwald, C. L. Schepens, and Dohrmann K. Pischel.

# Technical Papers

## Curarization by Rectal Suppository

Jean Delay and Jean E. Thuillier

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de la Clinique des Maladies Mentales  
et de l'Encéphale, Paris, France

We have found that the introduction into the rectum of a rabbit of a suppository containing a sufficient quantity of curare or curarelike compounds produces the same effect as that caused by intravenous injection. Curarization of the rabbit follows the same pattern in both cases: first, the ears drop; then there is a softening of the muscles of the neck; the head drops; and finally a complete quadriplegia is observed. In the case of an overdose this is followed by paralysis of the diaphragm with cessation of breathing; and, last, death is caused by heart failure.

Curarization by rectal suppository is less abrupt than by intravenous injection, taking 4-6 min, and it lasts longer. Relaxation continues for 3-5 hr. Physostigmine and eserine keep their effect as antidotes, permitting one to stop the curarization at will or in case of an overdose.

In order to demonstrate more objectively the effect of rectal curarization, we have made a neuromuscular preparation. A rabbit is slightly anesthetized by Nembutal injection. The sciatic nerve is isolated, and the inner branch receives current through the electrodes of a battery-operated excitator and is regularly stimulated to a constant rhythm. The gastrocnemius muscle of the animal is then prepared and a sheaf from the tendon is attached to a myograph which registers the contractions provoked by the excitation of the sciatic nerve. One thus obtains a graph of the muscular contraction, with constant amplitude and rhythm. If one introduces into the rectum of the rab-

bit a suppository containing 0.025 g/kg of 336 HC (iodoethylate of N,N bis-piperidyl-ethyl-piperazine) or 0.005 g/kg of D-tubocurarine or 0.005 g/kg of Flaxedil, there is a variable delay, constant for a given animal, after which one observes that the amplitude of the contractions decreases until there is no contraction at all, and the animal is completely curarized. Graphs A and B in Fig. 1 show the difference of effect between the suppository and the intravenous injection; C shows the antagonistic action of physostigmine.

These differences may be summarized as follows: Rectal administration by suppository permits (a) slower curarization; (b) a more persistent effect; and (c) a slower recuperation of muscular contractility.

This experimental procedure demonstrates for the first time, as far as we know, the use of a rectal suppository for the curarization of an animal. In clinical investigations, we have obtained interesting results in neurological and psychiatric syndromes by this procedure (1).

### Reference

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Manuscript received June 24, 1952.

## Invertase in *Palamnaeus bengalensis*

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As far as the writers are aware, knowledge of the physiology of digestion in scorpions is largely due to the extensive investigations of Pavlovsky and Zarin (1) on *Buthus*, but unfortunately these authors had little fresh material at their disposal and based their work on stored glycerin extracts. No invertase was, however, detected by these workers in the scorpion *Buthus*.

Our investigations were conducted on *Palamnaeus bengalensis*, the common large Indian scorpion, which lives in dry, shady, uncultivated high platforms of land and feeds on various types of insects, myriapods, and even on its own kind. Large quantities of fresh extracts of the liver were prepared from a number of well-fed specimens that had been lightly chloroformed and immediately dissected. Weighed quantities of the glands were ground with quartz sand and measured quantities of distilled water and filtered. The solution so obtained gave a pH of 7.1. Estimations of the enzyme were conducted, using the methods of Cole (2), Hawk et al. (3), Sumner and Somers (4), and Smith (5). All experiments were performed with parallel controls and blank solutions. Toluene was used as an antiseptic in each case.

For the detection of invertase buffered extracts

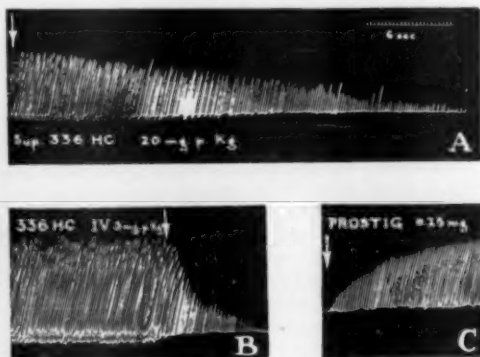


FIG. 1. Rabbit ♂ 3 kg neuromuscular preparation. (A) Contractions of the gastrocnemius muscle; curarization by rectal suppository. (B) Contractions of the gastrocnemius muscle; curarization by intravenous injection. (C) Decurarizing action by intravenous injection of physostigmine.

made in distilled water were allowed to act on 1% sucrose solution at 27° C. After 5 hr, Fehling's test was applied to the solutions, which were boiled for 3 min. The results were positive for invertase activity. In another set of experiments, a small quantity of the sucrose solution was mixed with the gland extract and left overnight at room temperature (20° C). This was tested with Benedict's sugar-reducing method next morning, with marked results. Several experiments were performed in each case, and sufficient evidence was obtained to show that invertase was present in the liver of *P. bengalensis*.

The work on the biochemical nature of the enzymes and their quantitative reactions in this scorpion is, however, being extended by one of us (M.S.K.).

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Manuscript received June 23, 1952.

### Paper Partition Chromatography in Taxonomic Studies<sup>1</sup>

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University of California, La Jolla

Paper partition chromatography, as applied to fresh tissues of several species of fish, yields results that seem to have value for taxonomic studies. The following technique is being used: (1) Approximately 8 mm<sup>3</sup> of various tissues, such as muscle, liver, and eye lens of fresh fishes, are placed on Whatman #1 filter paper and squashed with the aid of a glass pestle with a flattened tip, to form a spot about ½ in. in diameter. (Muscle proves to be the most favorable material.) (2) The tissue is allowed to dry at room temperature. (3) The chromatogram is developed in one direction by descending flow of the solvent. Two solvent mixtures are used. One is comprised of 2 parts of *n*-propanol, and 1 part of 1% ammonia; the other is a mixture of 4 parts of *n*-butanol and 1 part of glacial acetic acid, made up with 5 parts of water. (4) After development, the chromatograms are first studied under ultraviolet lamps for the presence of fluorescent spots. (5) The chromatograms are then sprayed with a 0.2% solution of ninhydrin in 95°

<sup>1</sup> Contributions from the Scripps Institution of Oceanography, New Series, No. 606.

<sup>2</sup> Institute of Genetics, University of Pavia, Italy; visiting professor, University of California.



FIG. 1. Ninhydrin-positive patterns of A, *Paralabrax clathratus*; B, *P. maculatofasciatus*; and C, *Hysterothorax traski*. Two samples of each species are presented.

ethanol, to which 5% 2,4,6-collidine is added before use. Black-and-white or colored photographs of the fluorescent and of the ninhydrin-positive pattern are made and kept for permanent record.

Fluorescent and ninhydrin-positive patterns of a certain tissue taken from various specimens of the same species are remarkably constant, irrespective of the size or age of the fish. On the other hand, patterns obtained from muscle of different species show constant and easily recognizable differences (Fig. 1). In general, in the preliminary tests, the closer the taxonomic position of any two or more species studied, the greater the similarity of their chromatographic patterns. No extensive attempts have been made to identify the chemical nature of the substances involved, but it can be said that free amino acids do not play an important role. Comparable results have been obtained

in other animal phyla. Preliminary results indicate that the same technique can be used to distinguish stocks of the same species belonging to populations geographically separated.

On the basis of the results obtained, it appears that this technique will become a useful tool in taxonomic and population-genetical studies, and that it may perhaps also be used for an understanding of phylogenetic relationships in biochemical terms. More complete accounts will be published elsewhere.

Manuscript received September 15, 1952.

## Area Balance in Color Harmony: An Experimental Study

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The importance of area in color design is generally recognized both by aestheticians and practicing artists. In fact, one recent authority on composition maintains that "... the choice of quantity is more important than the choice of colour" (1). From the practice of artists an empirical "rule" has developed concerning the proper balance of areas in a design. The accepted principle is that a large area of color at a low degree of saturation will balance a small area of highly saturated color; the principle is sometimes extended to lightness—balancing of the darks against the lights. When stated in quantitative terms, this "rule" is of particular interest to experimental aesthetics, and the object of the present preliminary investigation is to examine two quantitative hypotheses that have been proposed, with a view to testing their predictive value. The first hypothesis was suggested by A. H. Munsell (2), a practicing artist who developed the Munsell Color System, and the second was put forward more recently by Moon and Spencer (3).

Munsell gives the following quantitative "rule" for areas:

The stronger the color ... the smaller must be its area; while the larger the area, the grayer the Chroma. Thus, R 7/6<sup>2</sup> balances R 3/3 in the proportion of nine parts of the lighter red to forty-two parts of the darker red. In other words, these symbols will balance colors inversely as the product of their factors. This opens up a great field of area (2).

Cleland, in his "Practical Description of the Munsell Color System" (4), has stated the same principle in the following terms:

We ... have to take the Value into account in determining the amount of area of these two colors to be used if we are to arrive at a perfectly balanced color design; and this is done by the simple process of multiplying the Chroma by the Value of each of the colors.

<sup>1</sup> The author is grateful to H. J. Eysenck for his helpful comments and suggestions.

<sup>2</sup> That is, in terms of the usual Munsell notation: Hue Value/Chroma.

Moon and Spencer (3) also claim that relative area is a function of both value and chroma. They consider that a pleasing balance is obtained when the product of each area and its distance from the "adaptation point" are the same, in color-space. (The "adaptation point" is simply the general level to which the eye is adapted when viewing the color patches.) The color-space to which Moon and Spencer refer is a metric-space that they have developed by making a mathematical transformation of the C.I.E. color-space (5). The reason for constructing this particular space was to provide a suitable system for the geometrical formulation of color harmony; the ordinary C.I.E. space was considered unsuitable because it is an affine color-space, "where angles in general do not have any meaning and where distances in different directions cannot be compared" (5). It is not necessary, for the present purpose, to discuss the nature of this metric-space in detail, for it is correlated with the Munsell system, and Moon and Spencer's hypothesis may be translated in terms of Munsell notation. But it is necessary to consider their system very briefly, for it is in terms of the metric-space that they have put forward their basic postulate. This postulate is stated as follows: "A pleasing balance among  $n$  color patches is obtained when the scalar moments about the adaptation point in  $\omega$ -space are equal, for all the patches" (3). This postulate will become obvious from Fig. 1, which shows both the rectangular and cylindrical coordinates of Moon and Spencer's system.<sup>2</sup>

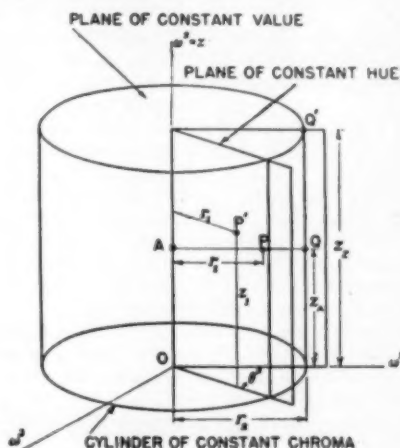


FIG. 1. Moon and Spencer's metric color-space, showing the Cartesian coordinate system ( $\omega^1, \omega^2, \omega^3$ ) and the cylindrical coordinate system ( $r, \theta, z$ ).

The planes of constant-hue are arranged at angles  $\theta$  about an achromatic axis ( $z$ ). Any color is represented by a point in the 3-space, as for instance  $P(r, \theta, z)$ . The adaptation point  $A$  is on the neutral axis. Sup-

<sup>2</sup> The author is grateful to the editor of the *Journal of the Optical Society of America* for permission to reproduce Fig. 1 from Moon and Spencer's article (3, p. 95).



pose there are any two colors,  $P$  and  $Q$ , of the same hue and of the same lightness as the adaptation point, but of different chromas; then  $P$ ,  $Q$ , and  $A$  are on the same horizontal line. If the color patch  $P$  has area  $s_1$  and  $Q$  has area  $s_2$ , then the scalar moments about  $A$  are  $s_1 r_1$  and  $s_2 r_2$ , and, according to Moon and Spencer's postulate, a pleasing balance is obtained when the moments are equal; i.e., when  $s_1 r_1 = s_2 r_2$ . As the principle is perfectly general, the points  $P$  and  $Q$  need be neither on the same horizontal line nor in the same plane. They may, for instance, be two points,  $P'$  and  $Q'$  in which case their moments will be:

$$s_1 \{r_1^2 + (s_1 - s_A)^2\}^{\frac{1}{2}} \text{ and } s_2 \{r_2^2 + (s_2 - s_A)^2\}^{\frac{1}{2}}$$

and, according to the postulate, there should be a satisfactory balance when these moments are equal. If this principle is to be tested by means of color samples it must be stated in terms of Munsell notation. This is possible because there is an approximate correspondence between  $r$  in the metric-space and Munsell chroma,  $\theta$  and Munsell hue, and  $s$  and Munsell value. Chroma is taken as equal to the number of units of  $r$  from the neutral axis, and value is taken as  $s/8$ . (This is in accordance with the work of Bellamy and Newhall [6] who have shown relationships between the units in the three Munsell scales.) The scalar moment of any color point about the adaptation point (Munsell N5) becomes, in Munsell terms:  $s\{(\text{chroma})^2 + 64(\text{value} - 5)^2\}^{\frac{1}{2}}$ ; i.e., equal to area of the color patch  $\times$  moment arm.

It is interesting to note that Moon and Spencer's postulate is identical with Munsell's "rule" for the case where the color patches and the adaptation point are all of value 5, for the moment arms are then equal to the chromas of the patches, and the areas required for satisfactory balance are inversely proportional to them. For example, suppose two small color patches,  $R\ 5/\ell$  and  $R\ 5/8$  of areas  $s_1$  and  $s_2$ , respectively, are presented against a large background of Munsell neutral grey (N5). In this case the second patch is of higher chroma than the first, and the product of the factors of the two patches are  $5 \times 6 = 30$ , and  $5 \times 8 = 40$ . Applying Munsell's rule, the area of the second patch must be adjusted so that it is  $3/4$  of the area of the first. By Moon and Spencer's method, the moment arm of the first patch is  $\{6^2 + 64(5-5)^2\}^{\frac{1}{2}} = 6$ , and that of the second is  $\{8^2 + 64(5-5)^2\}^{\frac{1}{2}} = 8$ , and a pleasing sense of balance is therefore obtained when the areas are adjusted so that the second is  $6/8$  of the first. Both hypotheses are stated quite explicitly, so they can be submitted to experimental test.

But before such a test can be undertaken, an assumption underlying the two hypotheses must be examined. This assumption, which is not made explicit by either Munsell or Moon and Spencer, is that a certain amount of agreement exists between individual preferences. Clearly, unless there is some measure of agreement concerning the most desirable ratios for color balance, the need for aesthetic formulas does not arise. This problem is a fundamental one throughout the whole field of experimental aesthetics and must be

considered in the present situation; so that, in fact, there are two questions which must be answered: first, is there some measure of general agreement between individual preferences for area-balance and, second, if such agreement exists, to what extent can it be accounted for by the two formulas that have been proposed?

Twenty subjects, representing a fairly wide range of occupations and interests, took part in the experiment; all were of normal color vision as tested by three standard tests, the Ishihara, Rabkin, and Farnsworth-Munsell, and none was familiar with the aesthetic theories under test. The experimental material consisted of 64 Munsell color patches arranged in the form of two sets, each containing 16 pairs of colors. Each pair of color patches was presented against a neutral grey background of Munsell value 5, and illumination was provided by a 500-w tungsten lamp in conjunction with a Macbeth daylight filter. The lamp had previously been calibrated at the National Physical Laboratory, to give a color temperature of  $2848^\circ\text{K}$  when operated at a specified voltage. Line voltage was controlled by means of a variac transformer. The color temperature was raised from  $2848^\circ\text{K}$  (i.e., C.I.E. standard Illuminant A) to  $6500^\circ\text{K}$ , by introducing a Macbeth filter especially designed, when used with Illuminant A, to give a match for color quality and an approximation in energy distribution to Illuminant C (i.e., standard artificial daylight). Subjects were instructed to adjust the areas of the two color patches in each pair to give the most pleasing balance. For each set of colors, the average observed ratios for the 20 subjects were then correlated with the predicted ratios, and the amount of agreement between subjects' preferences was determined by calculating the average intercorrelation coefficient.

It was found that the amount of agreement between individual preferences was remarkably high, the average intercorrelation coefficients being .672 and .732 for the two sets of colors. This result is in itself of considerable importance, for it suggests that, in this relatively unexplored part of the field of color aesthetics, there is the same objectivity of preference that has been found in studies of single colors (7) and color harmony (8). Turning next to the question of the extent to which the two formulas can account for this general agreement, correlations between predicted and observed ratios for the two sets of colors were .18 and .38 for Moon and Spencer's formula, and .73 and .59 for Munsell's empirical "rule." Without undertaking a more refined statistical analysis, these results indicate that Munsell's formula can account to a considerable extent for subjects' preferences: it does, in fact, account for about 35% and 53% of the total variance in the two sets of colors. On the other hand, Moon and Spencer's formula, in its present form, has no satisfactory predictive value.

The results indicate that further research of a more detailed nature on Munsell's formula would be worth while. They also suggest that the more fruitful



approach in this field is likely to be along fairly empirical lines rather than by deductive procedures for, whereas Munsell's simple rule was derived from his observations as a practicing artist, Moon and Spencer's formula was derived by more purely deductive arguments. This suggestion does not of course mean that Moon and Spencer's formula should be rejected on the basis of this one small-scale preliminary investigation.

In conclusion, it may fairly be claimed that, here as elsewhere in the field of color aesthetics, preferences show a marked degree of independence of purely personal taste and a dependence on objective stimulus properties, which suggests that they may have a fundamental biological basis in the perceptual system.

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## Adrenal Hypertrophy in the White Leghorn Cockerel after Treatment with Thiouracil and Thyroidectomy

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It has been established by previous investigators (1) that administration of thiouracil to the rat results in atrophy and degeneration of the adrenal gland. Recently Zarrow and Zarrow (2) have correlated this response with a decreased output of adrenocorticotrophic hormone by the pituitary of thiouracil-treated animals. In view of these data it seemed pertinent to report evidence of adrenal hypertrophy in White Leghorn cockerels similarly treated.

The effect of thiouracil was studied in two series of birds. The first series received 0.1% thiouracil in chicken mash from the 11th to the 19th day and was autopsied on the 20th day of age. The second series received a similar thiouracil diet from the 10th to 39th day and was autopsied on the 40th day of age. Control animals used in each case were fed a standard chicken mash.

The effect of thyroidectomy was studied in a series of 26 birds. Thyroidectomy was performed before the birds were 5 days old, and the animals were then placed on a standard chicken mash diet and otherwise treated in the same manner as 23 control birds received on the same day. The birds were autopsied at

TABLE 1  
EFFECT OF THIOURACIL ON ADRENAL WEIGHTS

Treatment	No. birds	Body wt (g)	Adrenal wt (mg)	Relative adrenal wt (mg/100 g body wt)
<i>Birds 20 days old at autopsy</i>				
Control	9	101	23.63	23.4
0.1% thiouracil 11th-19th day	4	93	25.30	27.2
<i>Birds 40 days old at autopsy</i>				
Control	9	398	52.33	13.4
0.1% thiouracil 10th-39th day	8	239	63.10	26.4*

\* Difference from control series significant at the 1% level.

40 and 42 days of age, at which time a careful macroscopic examination was made for thyroid tissue in the operated birds. Only those birds in which no thyroid tissue was found were considered to be totally thyroidectomized; those operated birds in which thyroid tissue was present were placed in a subtotally thyroidectomized series for analysis. In no case was the amount of thyroid tissue in the operated birds equal to that in the control animals.

It can be seen from Table 1 that after 9 days of thiouracil treatment the adrenals showed no significant change in weight, although the slight hypertrophy even at this early date is perhaps suggestive. After 29 days of treatment, however, a very marked hypertrophy of the adrenal was evident, the relative weight of the adrenals from the treated birds being nearly twice that of the adrenals from the control birds. The effect of thyroidectomy was even more striking (Table 2). A statistically significant increase in relative adrenal weight was induced by both partial and total thyroidectomy with total ablation being the more effective. In terms of absolute weight of the adrenal, however, no significant difference between the experimental and control birds was observed.

TABLE 2  
EFFECT OF THYROIDECTOMY ON ADRENAL WEIGHTS\*

Treatment	No. birds	Body wt (g)	Adrenal wt (mg)	Relative adrenal wt (mg/100 g body wt)
Control	23	377	55.08	14.6
Subtotal thyroidectomy	21	270	55.89	20.7†
Total thyroidectomy	5	128	52.76	41.2‡

\* Operations performed prior to 5 days of age; autopsied at 40 and 42 days of age.

† Difference from control series significant at 1% level.

‡ Difference from subtotal thyroidectomy series significant at 1% level.

The mechanisms involved are unknown at the present time, but it seems likely that they are different in the birds studied here than in the rat. Zarrow and Zarrow (2) have suggested that in the rat the athyroidic condition reduces the adrenocorticotrophic activity of the pituitary which results in the observed adrenal atrophy in this species. The hypertrophy reported here in the chick involves weight studies of the entire gland. It is still possible that the interrenal tissue was atrophied, which would perhaps indicate decreased adrenocorticotrophic activity of the chick pituitary as in the rat. Preliminary histological examination, however, did not reveal any degeneration of the interrenal cells. These studies are being pursued further in an attempt to clarify this aspect of the problem. An attempt to study the activity of adrenals from thyroidectomized and thiouracil-treated birds is being made by an analysis of the ascorbic acid and cholesterol content of such glands. It is also planned to investigate the adrenocorticotrophic activity of the pituitaries from such birds.

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## Flocculence in Yeast<sup>1</sup>

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The yeast *Saccharomyces cerevisiae* has two typical growth habits in liquid shake culture: (a) as a homogeneous disperse suspension consisting of single cells or cells with 1-2 buds and (b) as a noticeably

<sup>1</sup> Work performed under Contract No. W-7405-eng-26 for the Atomic Energy Commission.

particulate, nondisperse suspension consisting of clumps of cells of varying number. There is good agreement among the geneticists who have studied this character that it is under genetic control (1-3). There seems, however, to be some question as to which type of growth habit is dominant in a heterozygote. Pomper and Burkholder (1) reported that the disperse habit was dominant over the nondisperse, under specified conditions. Roman *et al.* (2) and Thorne (3) have since reported that flocculence is dominant over nonflocculence. It seems desirable, in an effort to resolve this apparent difference, to amplify the statement (1) that heterozygous diploids may be flocculent or nonflocculent depending on cultural conditions.

In our experience with this character, at least three external factors have been found to influence the expression of the "dominant" allele in a heterozygote: (a) time when scored, (b) carbohydrate used, and (c) concentration of the sugar. In the present study, six cultures were used. Three were diploids heterozygous for a single gene pair controlling the character; one was a triploid (4) heterozygous for the character (two alleles of disperse to one of nondisperse); the fifth was a diploid homozygous for the disperse allele; and the sixth was a diploid homozygous for the nondisperse (flocculent) allele.

A synthetic medium (5) at pH 6.8 was used, employing a standard inoculum (6) and rotating the tubes continuously in a 30° C constant-temperature room. The medium was prepared without any carbohydrate source, and tubed at twice the desired final concentration. Filter-sterilized solutions of the sugars were added aseptically to the medium after autoclaving, and the final volume was adjusted to 5 ml. The data obtained with the heterozygous diploids, a triploid, and two homozygous diploids are shown in Table 1. It should be noted that the haploid components of these hybrids show no dependence upon cultural conditions; i.e., a flocculent haploid remains flocculent and a nonflocculent haploid remains nonflocculent under all test conditions examined.

TABLE 1  
VARIATION IN YEAST GROWTH HABIT

Carbohydrate (%)		Growth Habit*							
		Heterozygous diploid†		Heterozygous triploid‡		Diploid homozygous for nonflocculence		Diploid homozygous for flocculence	
		1 day	2 days	1 day	2 days	1 day	2 days	1 day	2 days
Glucose	1	nf	nf	nf	nf	nf	nf	f	f
	5	"	f	"	sf	"	"	"	"
Fructose	1	sf	"	"	nf	"	"	"	"
	5	f	"	sf	f	"	"	"	"
Maltose	1	nf	nf	nf	nf	"	"	sf	"
	5	"	f	"	f	"	"	"	"
Sucrose	1	"	nf	"	sf	"	"	f	"
	5	"	f	"	"	"	"	"	"

\* nf = nonflocculent—i.e., disperse; f = flocculent; and sf = slightly flocculent (in appearance a mixture of both f and nf).  
† Essentially the same results were obtained with the three heterozygous diploids tested. All three cultures segregate 2:2 for nf and f types.

‡ The triploid was composed of an f haploid with a homozygous nf diploid.

It is clear from the data in Table 1 that, depending on the time, the carbon source and its concentration, the expression of flocculence may be variable in heterozygotes. The probability of scoring flocculent as dominant over nonflocculent increases with time of incubation and carbohydrate concentration. It seems unlikely that the results are due to selection of a mutation from heterozygosity to homozygosity (for nonflocculence), since the cultures were originally isolated on glucose-containing agar, have been maintained on glucose stock agar, and yet segregate regularly for flocculence and nonflocculence. It seems reasonable to conclude that the difference in results cited in the opening paragraph is due, in part at least, to the different experimental conditions employed,<sup>2</sup> as well as to possible genetic differences in the stocks used. The data in the present paper are a good example of an environmental effect on dominance relationships in heterozygotes.

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Manuscript received July 2, 1952.

<sup>2</sup> We have confirmed with our stocks the findings of Roman *et al.* (5) that heterozygotes grow flocculently in Difco yeast nitrogen base medium with 1% glucose. The physiological basis of flocculence may become more apparent when the factor determining its expression or lack of expression in these media is resolved.

## Food Intake and Hepatic Vitamin A in Castrated Mice

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The fact that castration is accompanied by significant increases in liver vitamin A stores (1-3) has been adequately confirmed. It is not known, however, whether this effect is due to increased ingestion of food by the experimental animal. This question has arisen repeatedly in studies of this nature, and an investigation of the problem is long overdue.

It is apparent that determinations of the food intake and body weight of the animals are essential, especially in work involving vitamin A. An integral part of the problem is an analysis of the laboratory diet for vitamin A content to ascertain whether changes in food intake might account for proportional differences in hepatic levels of the vitamin.

Fifty-nine C<sub>57</sub> mice were divided into intact and castrated groups, and placed on an *ad lib* diet of Purina fox chow, which was ground to form a coarse

powder and distributed in weighed feeding cups. The food intake of pairs of mice from each group was determined for 4 days; these animals were then returned to the respective series, and other pairs were placed in the feeding boxes. These determinations were made throughout the period of study. The vitamin A content of 4 samples of each batch of diet was determined during this time.

Body weight was recorded for each animal immediately prior to autopsy, at which time liver samples were analyzed for vitamin A content by the antimony trichloride method, using a Klett-Summerson colorimeter.

The content of vitamin A of each batch of diet was relatively consistent, with extremes of 1.5-1.8 IU/g; the average of all batches was 1.6 IU/g.

Even under very carefully controlled conditions, the measurement of food intake per animal per day is unsatisfactory. The general average, however, was remarkably consistent and showed no striking differences between the two groups; it is obvious, furthermore, that a significant influence of food intake on the recorded levels of vitamin A (Table 1) could be

TABLE 1

No. animals		Age in days	Food intake (g/mouse/day)		Body wt (g)		Vitamin A (IU/g)	
I*	C*		I	C	I	C	I	C
12	8	80	1.8	2.0	23.3	18.2	367	914
11	8	120	2.6	2.8	21.5	21.1	846	1178
12	8	180	3.1	3.5	26.8	23.7	459	1180

\* I = intact; C = castrated.

achieved only by relatively enormous differences in the amount of diet ingested. Body weight averages confirm the lack of differential food intake as a determining factor in the results of this study.

Table 1 illustrates clearly the marked increase in liver stores of the vitamin in castrated mice. It is patently inconceivable that a threefold change in vitamin A content is due to a difference of .2-4 g diet/mouse/day. That these values are not peculiar to the period studied is amply demonstrated in the results of long-term experiments to be published shortly.

The factors responsible for the increased levels of hepatic vitamin A in castrated rats and mice are unknown. Differences in absorption, utilization, and destruction of the vitamin, although of doubtful significance because of the relatively small amount ingested, require systematic study. Similarly, shifting of the minute stores from other parts of the body to the liver could not account for the marked changes reported. All these factors, however, must receive intensive investigation.

The suggestion that food intake may have a significant influence on the vitamin A stores of castrated

animals is repeatedly advanced, despite observations which argue against this possibility (4-6). The vitamin A content of the diet was not determined in these studies, however, and further convincing proof was not available. The present paper furnishes these data and, with measurements of food intake, body weight, and liver vitamin A, substantiates the belief that the amount of diet consumed has no effect on the body stores of the vitamin in the castrated mice studied.

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Manuscript received June 23, 1952.

## Comments and Communications

### Uncommitted Researchers

IN RE Benson's letter (*SCIENCE*, **116**, 233 [1952]): Most men who go in for science teaching and/or research have had their education given to them and have taken to science for their own diversion. The true scientist is only concerned with following his vocation to the best of his ability within the limits of his capacities. He is not properly concerned with hours of work, wages, fame, or fortune. For him an adequate salary is one that provides decent living without frills or furbelows. No true scientist wants more, for possessions distract him from doing his beloved work. He is content with an Austin instead of a Packard; with a table model TV set instead of a console; with factory- rather than tailor-made suits; with dollar rather than hand-painted neckties, etc., etc. To boil it down, he is primarily interested in what he can do for science, not in what science can do for him. The breed, unfortunately, is dying out.

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### Pollen Counts and the Hay Fever Problem

THE transport of particulate matter by the atmosphere and, in particular, the dispersion of such matter through large volumes of air are—and have been—subjects of extended research. Much of the study to date has been devoted to problems attending the disposal of waste gases and vapors from industrial smokestacks, where there is essentially a point source of continuous emission of smoke and where the rate of emission is independent of atmospheric conditions. Such a situation has been analyzed by Sutton (1) for very small particles,  $1\ \mu$  or less in diameter. The theory is far from complete, however, as evidenced by the recent efforts of Hewson et al. (2) to introduce a new approach to the subject.

In respect to airborne pollens, the problem of atmospheric transport and dispersion is still further complicated by the following considerations: (1) The emission of the pollen grains into the atmosphere depends directly on a complex of atmospheric condi-

tions, including (a) low-level turbulence and gustiness to shake the pollen grains loose and to transport them upward into the air stream; (b) temperature and humidity suitable for ripening and drying the pollen grains. (2) The sources of pollen grains are spread more or less randomly over the landscape. (3) The pollen grains are in the  $15\text{--}20\ \mu$  diameter range of sizes, the dispersion of which has been very little studied.

This means that there is at present no theory applicable directly to the problem of transport of hay fever pollens. It is possible, however, to speculate on the nature of the processes whereby pollens become airborne, and on the results of research on the dispersion of smaller particles. By this means one may crudely visualize the pollen distribution process.

To a sufficient approximation, the terminal velocity of fall of a ragweed pollen grain is about 2 ft/min with respect to its air environment. If one assumes that a strong gust strikes the natural pollen source and lifts the pollen grains to some height,  $h$ , above the ground, the distance to which the pollen grains will be carried may be estimated by the use of reasonable assumptions about the average vertical air speed along the path. This fails to give information as to the dispersion, or lateral spread, of the cloud of pollen grains initially involved. As emphasized by Cramer (2), this spread is related to accelerations of the air stream which, in turn, produce accelerations of the particles forming the cloud and cause them to separate in some kind of stepwise process.

Although Sutton's theory gives an approximate solution for the dispersion of suspended particles of the order of  $1\ \mu$  or less in diameter, it is clear that the larger the particle considered, the slower will be the rate of dispersion and the more rapid will be the rate of sedimentation. Since rate of dispersion is a function of acceleration, it will bear some proportionality to force/mass, where mass is proportional to  $D^3$  and force is proportional to  $D^2$ . Thus rate of dispersion is related inversely to  $D$ , the diameter of the pollen grains.

Standard methods of measuring the "pollen count"



are universally based on the assumption that the pollen grains are dispersed uniformly through vast volumes of air. This is the only assumption on which one can base the premise that the pollen counts taken at U. S. Weather Bureau city offices are meaningful to the residents of cities. It is, however, absolutely impossible to attain a state of uniform dispersion of particles the size of pollen grains in any appreciable volume of open air. Concentrations at any specified point depend primarily on the distance up-wind to the nearest pollen source and on the wind speed. Because of the slow rate of dispersion, the random nature of the location of sources, and the random occurrence of upward gusts, the pollen count may change quite drastically from one point to another only a short distance away and from one moment to another at a given point. It is undoubtedly this anisotropy that renders "official pollen counts" clinically useless, although this does not necessarily mean that pollen counts are useless. Counts made at any point in conjunction with pertinent meteorological observations (i.e., wind speed and direction) would give useful information on the relations of pollen counts to the weather. It is even conceivable that particularly offensive local pollen

sources could be located and eradicated by this method. In any case, the hay fever patient, whose allergy is reasonably specific, will derive greater benefits from the correlation of personal weather observations and symptoms, or pollen counts, for by this means he will be forewarned of unfavorable or favorable conditions to come.

Instead of reporting of "pollen counts," local weather bureau and news dispensers would be more helpful if they would forecast wind speeds and directions, and the general expected state of air pollution (*stability*, in meteorological parlance). These are elements of the weather and, contrary to an apparent popular impression, they are fully as important as the temperature and humidity in a given locality.

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## Book Reviews

**Introduction to Geophysical Prospecting.** Milton B. Dobrin. New York-London: McGraw-Hill, 1952. 435 pp. \$7.00.

The author has produced a much-needed textbook, intermediate in character between the exhaustive treatises by C. A. Heiland and J. J. Jakosky, and the more popular treatment by Eve and Keyes. The treatment is similar to L. L. Nettleton's in *Geophysical Prospecting for Oil*, but is more exhaustive and, furthermore, attempts to include a coverage of geophysics in mining exploration. Because of the author's association with a petroleum company, it is to be expected that the treatment of oil geophysics will be more accurate and more thorough than that of mining geophysics. By far the larger part of the book is devoted to the geophysical techniques that have contributed so greatly to the development of the oil industry—108 pages being devoted to seismic technique, 89 pages to gravitational techniques, and 73 pages to magnetic prospecting, whereas electrical methods (exclusive of well-logging) are covered in 28 pages, and radioactive methods in 19 pages. The remaining 100-odd pages are devoted to the integration of geophysical methods, well-logging methods, radio position locations, and current research in geophysical exploration. The allocation of space reflects the current relative importance and extent of application of geophysical methods in the oil industry in contrast with the mining industry.

The treatment of the various subjects is mathematical in approach, but does not require knowledge of mathematics beyond trigonometry. It is not an elementary text suitable to a survey course for geologists or engineers, but it should be valuable as an introductory text for those who expect to be, or to work closely with, geophysicists. Each branch of geophysics is dealt with systematically, and the fundamentals of that geophysical science to which each exploration technique is related is considered. Thus, the subject of gravitational prospecting is related to the broader field of the earth's gravitational force; magnetic prospecting is set against the background of the earth's magnetic field; and earthquakes and the information they yield about the internal constitution of the earth form the background for the discussion of reflection and refraction prospecting. Considerable attention is devoted to the instruments used in the various methods, the treatment of the data obtained, and the interpretation of the results.

The few paragraphs devoted to the history of geophysical prospecting give the erroneous impression that the electrical and magnetic techniques are recent developments. No acknowledgment appears of the early work of Robert Fox, of Cornwall, in 1830, and of Carl Barus in Nevada in 1880, on the spontaneous polarization or self-potential method, nor of the fact that Robert Fox was the first to suggest that resistivity measurements of the earth could yield geological



information. The work by C. and M. Schlumberger is mentioned, but no credit is given to Hans Lundberg for his pioneering developments in the field of alternating current prospecting. The history of magnetic prospecting also suffers from overcondensation; magnetized bars were used in prospecting for iron ore in Sweden as early as 1640, and a dip needle survey was made of New Jersey about 1760.

Some criticism must be leveled against carelessness in editing and proofreading. Some of the bibliographic references are incorrectly cited, and there are also omissions and errors in the text, affecting particularly the field of mining geophysics. The spontaneous polarization method is omitted from the tabulation on page 5, and the electrical resistivity technique is included therein as though its only function were to determine the depth to interfaces, such as water tables and bedrock. Mention of its application in the search for quartz veins, for shear zones, and in mapping geological structures is omitted. The author states (p. 286) that the spontaneous polarization method is "... valid only for locating ores within 100 feet of the surface." The depth limitation placed upon the method by those cognizant with the procedure is usually 300 feet. On page 290 he states that, although the strongest spontaneous polarization potentials "... are excited in sulphide ores such as pyrites, a number of other minerals such as pyrrhotite and magnetite, give rise to spontaneous polarization patterns. ..." Magnetite does not ordinarily give rise to spontaneous polarization currents, and pyrrhotite is just as much a sulfide as pyrite. The author tends to use the terms "ore" and "sulphides" as though the two were synonymous, to which any mining engineer or geologist would take violent exception. A line or so further down from

the above quotation, the author refers to a 1700 mv potential anomaly in Peru. This is an impossible potential, and the value reported was actually 700 mv.

It is to be hoped that in future editions of this book the subject of mining geophysics will be more adequately treated, and that errors and omissions such as those cited above will be remedied. The present edition suffers from the fact that the author, himself an oil geophysicist, has submitted his manuscript for review only to other oil geophysicists, who have given a cavalier treatment to the geophysical techniques used in mining exploration. Aside from this criticism, the author is to be congratulated on having produced a book that fills a serious gap in geophysical literature.

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*Proceedings of the London Conference on Optical Instruments 1950.* New York: Wiley, 1952. 264 pp. \$7.00.

The London Conference on Optical Instruments, sponsored by the Royal Society through its Subcommittee for Optics, was held in July 1950 at the Imperial College. The present volume represents a collection of the papers given, including the introductory address by Sir Thomas R. Merton. Altogether, 21 papers are included, most of them followed by summaries in English and French. The different topics discussed concerned photographic and projection lenses, reflection microscopy, gratings and grating instruments, phase-contrast microscopy, spectrophotometers, reflecting telescopes, and new optical materials.

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## Scientific Book Register

*The Nile.* A general account of the river and the utilization of its waters. H. E. Hurst. London: Constable; New York: Macmillan, 1952. 326 pp. Illus. \$6.00.

*The Permeability of Natural Membranes.* Reissue. Hugh Davson and J. F. Danielli. New York: Cambridge Univ. Press, 1952. 365 pp. Illus. \$6.00.

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*The Oxidation States of the Elements and Their Potentials in Aqueous Solutions.* 2nd ed. Wendell M. Latimer. New York: Prentice-Hall, 1952. 392 pp. Illus. \$7.50.

*Problems of Consciousness.* Transactions of the Third Conference, March 10-11, 1952, New York. Harold A. Abramson, Ed. New York: Josiah Macy, Jr. Fdn., 1952. 156 pp. Illus. \$3.25.

*Computing Methods and the Phase Problem in X-Ray Crystal Analysis.* Report of a conference held at The Pennsylvania State College, April 6-8, 1950. Ray Pepinsky, Ed. State College: X-Ray Crystal Analysis Laboratory, Pennsylvania State College, 1952. 390 pp. Illus. \$7.50.

*Elements of Food Engineering.* Vol. I. Milton E. Parker, with collab. of Ellery H. Harvey and E. S. Stahler. New York: Reinhold, 1952. 386 pp. Illus. \$8.75.

*Photoconductivity in the Elements.* Trevor Simpson Moss. New York: Academic Press; London: Butterworths, 1952. 263 pp. Illus. \$7.00.

*Essentials of Fluid Dynamics: With Applications to Hydraulics, Aeronautics, Meteorology and other Subjects.* Trans. of 3rd ed. of *Führer durch die Strömungslehre*. Ludwig Prandtl. New York: Hafner, 1952. 452 pp. Illus. \$6.00.

*The Molecular Theory of Fluids.* Monographs on the Rheology of Natural and Synthetic Products. Herbert S. Green. Amsterdam: North Holland Pub.; New York: Interscience, 1952. 264 pp. Illus. \$5.75.

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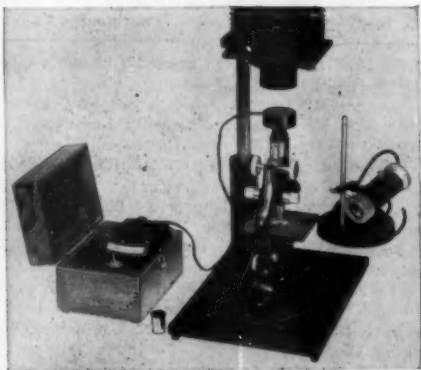
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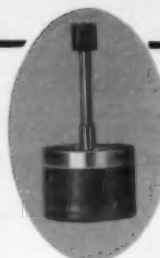
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